



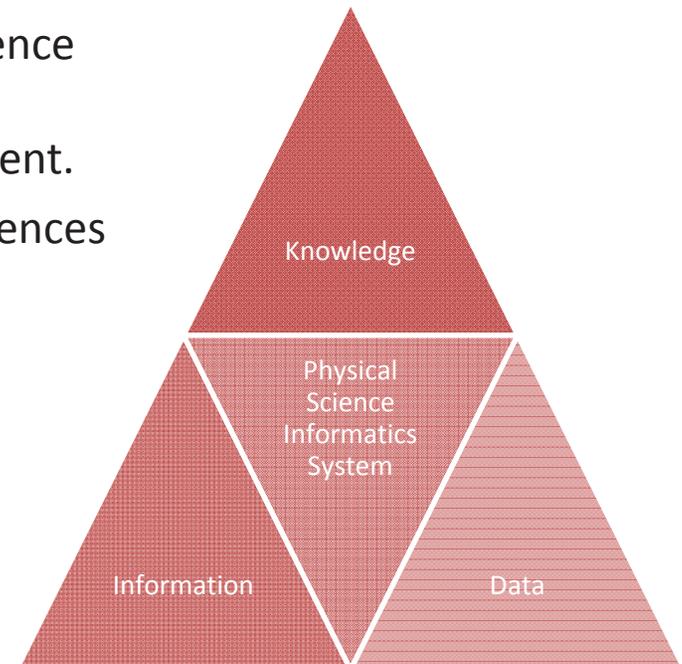
Physical Science Informatics: Providing Open Science Access to Microheater Array Boiling Experiment Data

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Objective



- Physical Science Informatics system implements Office of Science and Technology Policy (OSTP) memorandum, Feb. 22, 2013 entitled “Increasing Access to the Results of Federally Funded Scientific Research” by enabling multiple researchers simultaneous, **open-science**, access to synergistically build upon ISS data.
- Maximize the value of this important data by mass disseminating past, current, and future ISS physical science data to the broad science, engineering, and STEM community including industry, academia, and government.
- Accelerate from ideas to state-of-the-art of physical sciences research and to products, publications, and patents.



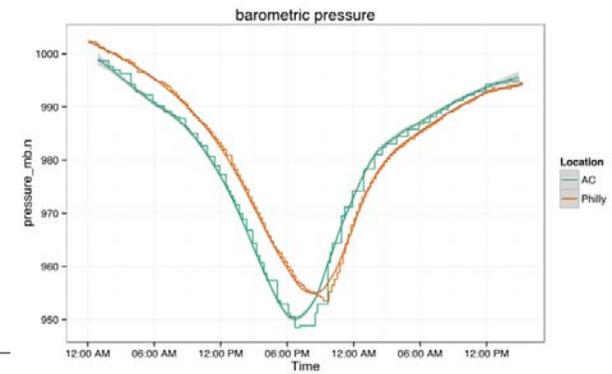
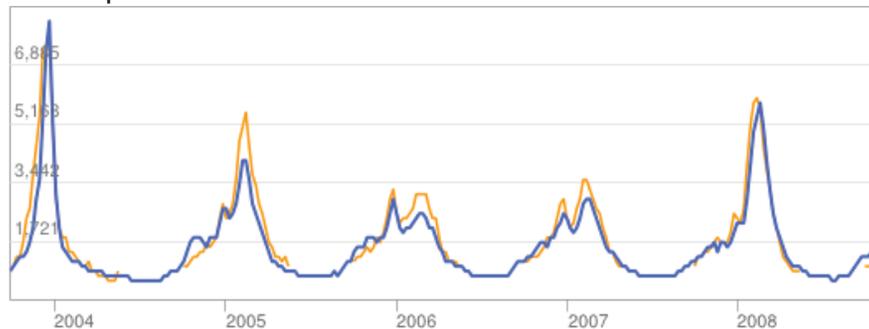
Open Science Examples



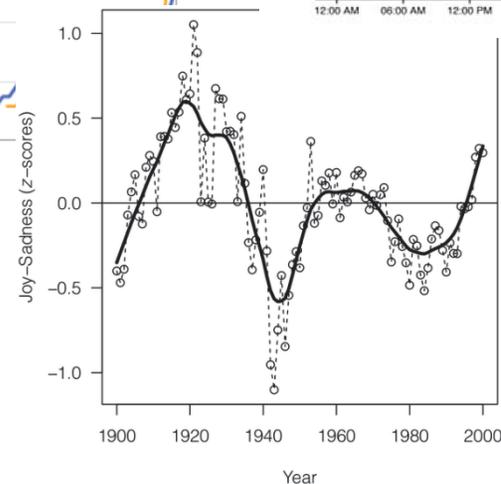
- Data science: A new emerging field with the goal of “extracting meaning from data and creating data products”. [definition courtesy of Wikipedia.]
- Has emerged as a new field to glean knowledge and new understanding from the large volume and diversity of data being published or available and accessible on the internet.

- **Examples:**

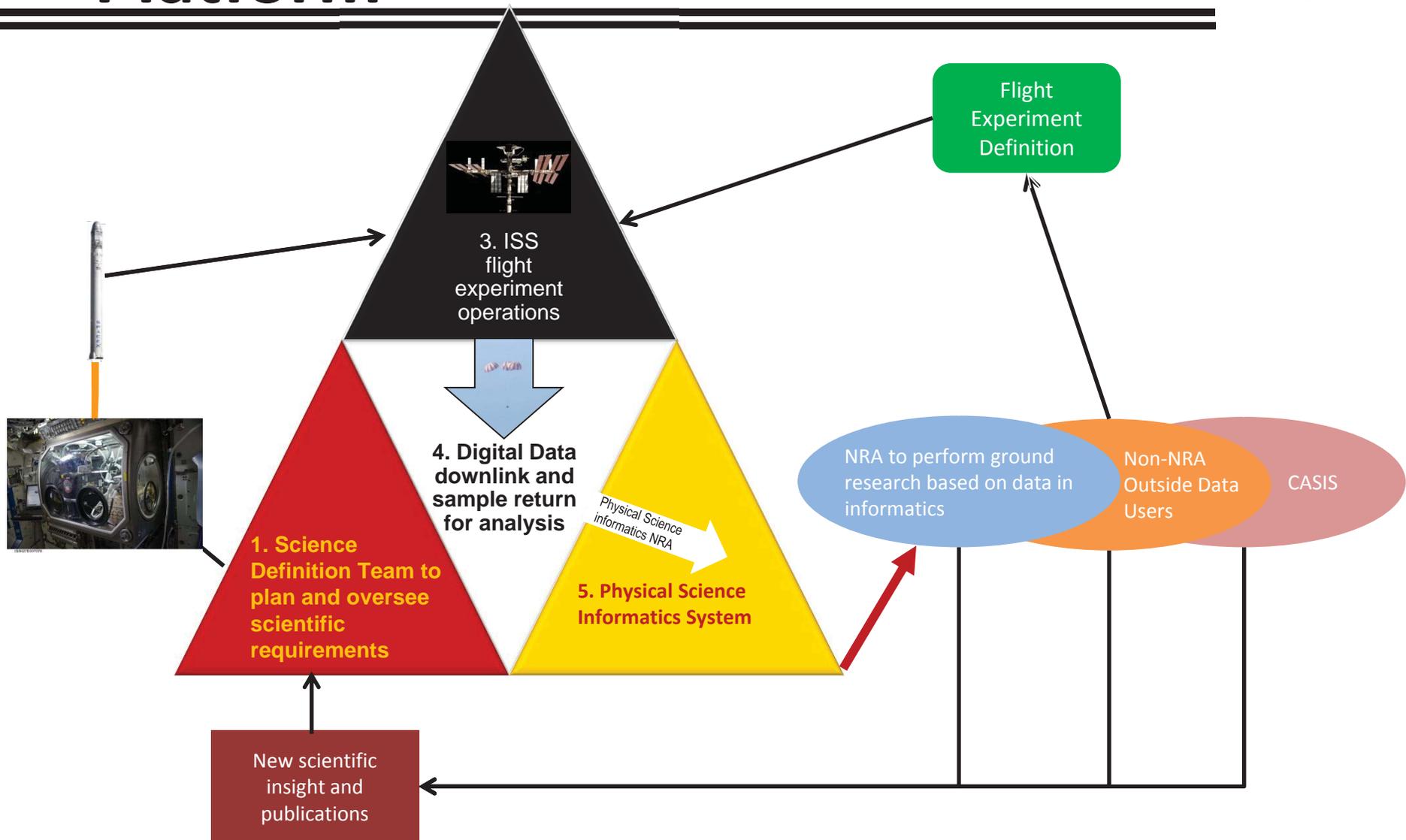
- Tracking Hurricane Sandy: Barometric pressure data from local weather stations, available on-line, accurately track the storm's path.



- Google researchers discovered close relationship between searches on flu-related topics and spread of influenza. Published in Nature Vol 457, 19 February 2009, doi:10.1038/nature07634
- Human behavior researchers using Google n-gram database (data from Project Gutenberg) found evidence for distinct historical periods of positive and negative moods in 20th century books.



Open Science Campaign Platform*



22 Sept 2014

*Marshall Porterfield – based on the ISS Science Campaign White Paper 2013



BXF Overview

The Boiling eXperiment Facility was installed in the Microgravity Science Glovebox (MSG):

- Two distinct experiments:
 - Micro-heater Array Boiling Experiment (MABE) PI: Prof. Jungho Kim, University of Maryland
 - Nucleate Pool Boiling Experiment (NPBX) PI: Prof. Vijay K. Dhir, University of California at Los Angeles
- *Normal*-perfluorohexane, C_6F_{14} , as the test fluid
- Operated between pressures of 60 to 244 kPa and temperatures of 35 to 60 °C.
- Measured Pressure and bulk fluid temperature.
- Acquired standard rate video.

Timeline

- BXF was delivered to the ISS aboard ULF-5, which launched in February, 2011.
- BXF was installed on Tuesday March, 22.
- Week 1: Hardware setup and checkout, MABE and NPBX heater characterizations
- Weeks 2 and Week 3: MABE and NPBX test points .
- On Monday, April 11, anomalous pressure readings tripped the BXF safety circuit, halting operations. Attempts to restart/reset/recycle BXF did not correct these readings and BXF was shut down.
- By this point MABE completed 260 of 540 tests. NPBX completed less than half of planned tests.
- On-orbit troubleshooting was performed via ground-control.
- Limited NPBX operations could still be performed without failed power bus.
- BXF was removed from MSG and returned on ULF-7.



ISS027E007156

ESA Astronaut Paulo Nespoli installing BXF in MSG

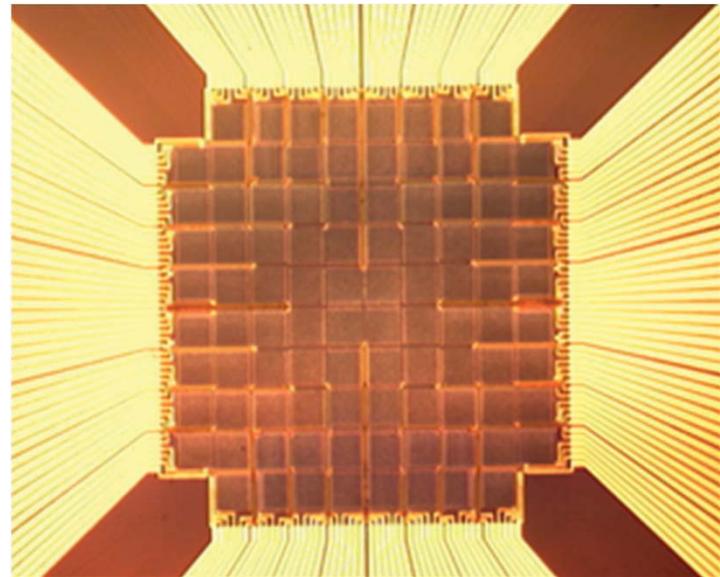
Microheater Array Boiling Experiment (MABE)



Determined the local boiling heat transfer mechanisms in microgravity for nucleate and transition boiling and the critical heat flux by examining the position of the liquid and vapor adjacent to the heater.

MABE was incorporated two 96-element microheater arrays, to measure localized heat fluxes while operating at a constant temperature.

- 2.7 by 2.7 mm (not acquired)
- 7.0 by 7.0 mm



Physical Science Informatics Platform



- **Accessibility** - Available to the national and international user community, using popular devices such as iPhone, iPad, Android, PC, Mac, Linux with web-based Google like search capability
- **Collaboration** - Allow for data to data links, and provide researchers the ability to comment about the data in either private or public discussions
- **Generate metric and usage reports** - Track usage for NASA managers and the science definition teams in planning, gap analysis, data ranking, student (undergraduate and graduate) impact, and for future system improvement.
- **Security and Access Controls** - Access controls will protect the data according to the data agreement and to support security controls for SBU, International Traffic in Arms Regulations (ITAR), company proprietary, or Export Administration Regulations (EAR), data system will need to be on a NASA moderate security plan
- **Export tools** are available to through a set of web services so that a variety of research tools can be used to analyze the data.

Requesting Access



Website access requires a USERID and Login.

Submit form at <http://psi.nasa.gov/Request.aspx>:

- First, Middle and Last Name
- Phone
- Email
- Organization
- Address
- City
- Country
- State
- Postal Code
- Citizenship
- Company
- Manager's Information
 - First and Last Name
 - Phone
 - Email
- Projects (NASA tracks who uses the database and what they use it for. Ultimately, this is one metric used to warrant continuation of this resource)
- Justification

PSI Introduction Page



URL <http://psi.nasa.gov>

Advanced Search

ISS Physical Science Informatics System

BROWSE BY - [Facilities](#) [Investigations](#) [Investigator Names](#)

[home](#) [help](#)

Welcome to ISS Physical Science Informatics System

Overview:
NASA's Physical Sciences Research Program, along with its predecessors, has conducted significant fundamental and applied research, which has led to improved space systems and produced new products offering benefits on Earth. NASA's experiments in the various disciplines of physical science, reveal how physical systems respond to the near absence of gravity. They also reveal how other forces that on Earth are small compared to gravity, can dominate system behavior in space. The International Space Station (ISS) is an orbiting laboratory that provides an ideal facility to conduct long-duration experiments in the near absence of gravity and allows continuous and interactive research similar to Earth-based laboratories. This enables scientists to pursue innovations and discoveries not currently achievable by other means. NASA's Physical Sciences Research Program also benefits from collaborations with several of the ISS international partners—Europe, Russia, Japan, and Canada—and foreign governments with space programs, such as France, Germany and Italy. The scale of this research enterprise promises new possibilities in the physical sciences, some of which are already being realized both in the form of innovations for space exploration and in new ways to improve the quality of life on Earth.

Research Areas:

Biophysics: biological macromolecules, biofluids, biomaterials, and biological physics

Combustion Science: spacecraft fire safety, droplets, gaseous - premixed and non-premixed, solid fuels, and supercritical reacting fluids

Complex Fluids: colloids, liquid crystals, foams, non-newtonian fluids, and granular flows

Fluid Physics: two-phase flow, phase separation, boiling, condensation and capillary and interfacial phenomena

Fundamental Physics: space optical/atomic clocks, quantum test of equivalence principle, cold atom physics, critical point phenomena, and dusty plasmas

Materials Science: crystal growth, metal and alloys, electronic materials, glasses and ceramics, and polymers

Implementing Centers:
NASA's Physical Sciences Research Program is carried out at the Glenn Research Center (GRC), Jet Propulsion Laboratory (JPL) and Marshall Space Flight Center (MSFC).

Heritage:
Space Life and Physical Sciences Division 2012 - present
ISS Research Project 2006-2012
Advanced Life Support - Life Support and Habitation Program 2004-2006
Office of Biological and Physical Research Program 1998-2004
Microgravity Research Program 1984-1998



NASA Official: Teresa Miller

MSFC Safety Reporting System
Privacy and Legal Statements

Curator: Julia M Reynolds
Powered by the Athena Platform

Investigations Page



General Search, searches all records and attached files

The screenshot displays the PSI Physical Science Informatics System (PSI) interface. At the top left is the NASA logo, and at the top right is the PSI logo with the text "PHYSICAL SCIENCE INFORMATICS SYSTEM". Below the logos is a search bar and a navigation menu with buttons for "Facilities", "Investigations", "Publications", "Reports", "Research Area", "Researchers", and "more...". A red banner above the search bar indicates that the "General Search" function searches all records and attached files. The search results are displayed in a table with the following entries:

Investigation Name	Category
<input type="checkbox"/> Capillary Channel Flow (CCF)	Investigations
<input type="checkbox"/> Capillary Flow Experiment (CFE)	Investigations
<input type="checkbox"/> Capillary Flow Experiment-2 (CFE-2)	Investigations
<input type="checkbox"/> Constrained Vapor Bubble (CVB)	Investigations
<input type="checkbox"/> Constrained Vapor Bubble-2 (CVB-2)	Investigations
<input type="checkbox"/> DECLIC, Directional Solidification Experiment (DSI)	Investigations
<input type="checkbox"/> DEvice for the study of Critical LIquids and Crystallization - High Temperature Insert-Refight (DECLIC HTI-R or SCWM/HTI-R)	Investigations
<input checked="" type="checkbox"/> Microheater Array Heater Boiling Experiment (MABE)	Investigations
<input type="checkbox"/> Nucleate Pool Boiling Experiment (NPBX)	Investigations

Experiment Record



Inside NASA Firewall Only to edit/update/add new records

Export reports to excel or PDF

Generate reports to compare data or identify data gaps

Investigation Overview Tab



Microheater Array Heater Boiling Experiment (MABE)

Edit Record Download Record Generate PDF Share

Was this information helpful? thumbs up 0 thumbs down 0

Notify Me

General Investigat... Scientific... Engineerin... Resulting ... Comments (0)

Investigation Overview

Research Objectives: Boiling efficiently removes large amounts of heat by generating vapor from liquid; this process is currently being used in many power plants to generate electricity. An upper limit, called the critical heat flux, exists where the heater is covered with so much vapor that liquid supply to the heater begins to decrease, potentially destroying the heater. Microheater Array Boiling Experiment (MABE) d ... Show More+

Research Overview: Microheater Array Boiling Experiment (MABE) is one of two investigations scheduled to operate in the Boiling eXperiment Facility (BXF). The other investigation is Nucleate Pool Boiling Experiment (NPBX). Show More+

Understanding of microgravity effects on boiling mechanisms is critical to the proper design of heat removal equipment for use in space-based applications.

Space Applications: In microgravity, a bubble can cover an entire heater array instead of just a small area, resulting in burnout of components if local hot spots are present. The increased spatial resolution of these measurements will enable the extent of the dry spot to be measured along with the heat transfer from the liquid surrounding the dry spot. This technique can be applied to other areas including spray coo ... Show More+

Earth Applications: The proposed research has shown that transient conduction is the dominant heat transfer mechanism in boiling of refrigerants-like fluids. This research will provide insight into creating more efficient cooling systems on Earth. Show More+

Other Information: MABE Other Information Show More+

Scientific Data and Information



Microheater Array Heater Boiling Experiment (MABE)

Edit Record Download Record Generate PDF Share

Was this information helpful? 0 0

Notify Me

General Investigat... Scientific... Engineerin... Resulting ... Comments (0)

Scientific Data and Information

Experiment Data: [MABE Test Runs](#)

Science Requirements Document(s): [SRD_04032.pdf](#)

Where the Video and Data will be Stored

Experiment Definition

22 September 2014

13

Engineering Data And Information



Microheater Array Heater Boiling Experiment (MABE)

Edit Record Download Record Generate PDF Share

Was this information helpful? 0 0

Notify Me

General Investigat... Scientific... Engineerin... Resulting ... Comments (0)

Engineering Data and Information

Engineering Drawings & Documents: Displaying 16 files.

- M01A2071_TEST CHAMBER ASSEMBLY.pdf
- M01A2131_TEST CHAMBER TOP PLATE ASSEMBLY.pdf
- M01A2151_COOLING CHAMBER ASSEMBLY.pdf
- M01A2161_MABE HEATER BONDING ASSEMBLY.pdf
- ... CARTRIDGE HEATER, COTS ASSEMBLY.pdf
- ... HERMISTER 3in COTS ASSEMBLY.pdf
- ... HERMISTER 6 in COTS ASSEMBLY.pdf
- ... HOUSING_TEST CHAMBER.pdf
- ... HOUSING_COOLING CHAMBER.pdf
- ... OVER_COOLING CHAMBER.pdf
- ... LATE_TEST CHAMBER...
- M01D1721_DUCT, MIXING, TES
- M01D1731_DUCT, MIXING, TES
- M01L2671_BXF_MSG LAYOUT
- M01C0044_BXF FLUIDS...

Increment(s): [Increment 25/26](#)
[Increment 27/28](#)

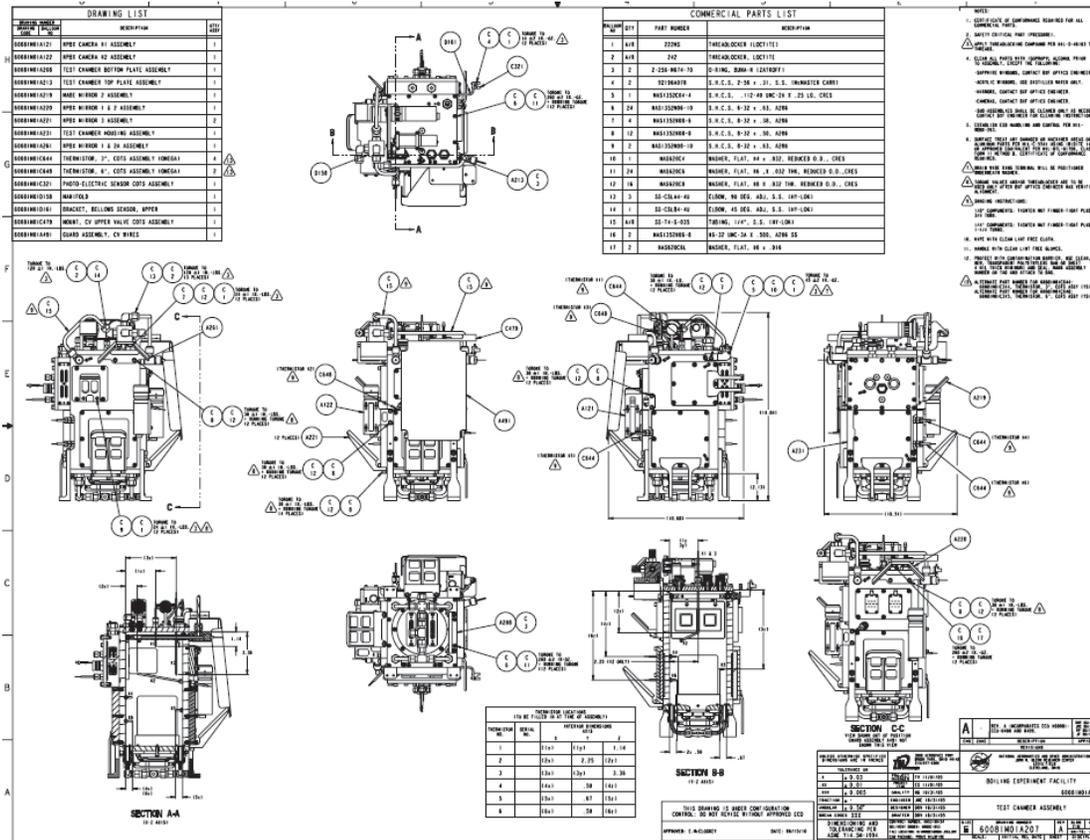
Facilities: [Microgravity Science Glovebox \(MSG\)](#)

Selected Drawings & Engineering Reports and Test Data Relevant to Analysis of Scientific Data.

Other Experiments Operating during Same time frame.

ISS Facility Used

Engineering Data



Note:

- Units are typically in SAE (inches, pounds, etc.)
- BXF had several hundred drawings, analyses, reports, etc.
- Only those files that are needed for interpretation of science data (for example position of sensors) have been entered.
- Other files can be requested.
- Some files will not be entered; for example, drawings related to hardening of high-speed camera because of proprietary nature.

Current Engineering Data Online



Drawing No.	Title	Rationale
60081M01A207	TEST CHAMBER ASSEMBLY	Overall Assembly
60081M01A213	TEST CHAMBER TOP PLATE ASSEMBLY	Position of Pressure Sensor Taps
60081M01A215	COOLING CHAMBER ASSEMBLY	Positioning of Heater Arrays and Backside Cooling
60081M01A216	MABE HEATER BONDING ASSEMBLY	Positioning of Heater Arrays
60081M01C311	CARTRIDGE HEATER, COTS ASSEMBLY	Bulk Fluid Heater
60081M01C314	THERMISTER, 3", COTS ASSEMBLY	Bulk Fluid Temperature Sensor
60081M01C315	THERMISTER, 6", COTS ASSEMBLY	Bulk Fluid Temperature Sensor
60081M01D110	HOUSING, TEST CHAMBER	Test Chamber
60081M01D169	HOUSING, COOLING CHAMBER	Backside Cooling Chamber
60081M01D171	PLATE, TEST CHAMBER TOP	Top of Test Chamber
60081M01D172	DUCT, MIXING, TEST CHAMBER, STRAIGHT	Annular Tube for Bulk Fluid Heater
60081M01D173	DUCT, MIXING, TEST CHAMBER, ANGLE	Annular Tube for Bulk Fluid Heater
60081M01L267	BXF/MSG LAYOUT	All Components
60081M01S291	BXF FLUIDS SCHEMATIC FLIGHT SYSTEM	Fluid System Schematic
	BXF Critical Design Review Charts	

Publications and Other Results



The screenshot shows a web interface for a NASA data record. The main title is "Boiling Experiment Facility for Heat Transfer Studies in Microgravity. 46th AIAA Aerospace Sciences Meeting and Exhibit. January 2008". Below the title are buttons for "Edit Record", "Download Record", "Generate PDF", and "Share". There is a feedback section with "Was this information helpful?" and thumbs up/down icons, and a "Notify Me" checkbox. The record details are shown in a "General" tab, including fields for Title, Author(s), Reference, Abstract, Detailed Author Information, Publication Year, and Link to Publication. A green arrow points from a red callout box to the "Link to Publication" field.

Title: Boiling Experiment Facility for Heat Transfer Studies in Microgravity

Author(s): R DeLombard, JB McQuillen, D Chao

Reference: R DeLombard, JB McQuillen, D Chao. "Boiling Experiment Facility for Heat Transfer Studies in Microgravity". 46th AIAA Aerospace Sciences Meeting and Exhibit. January 2008

Abstract: Image Only

Detailed Author Information: [McQuillen, John B.](#)

Publication Year: 2008

Link to Publication: [Boiling Experiment Facility for Heat Transfer Studies in Microgravity](#)

Some reports are on-line and publicly available, However, others may require a subscription to the appropriate journal .

Plans



-
- **PSI Database becomes publicly available during October 2014.**
 - **Limited Data for MABE is on-line.**
 - **Drawings**
 - **Reports**
 - **Links to publications**
 - **“Raw” Excel Spreadsheets for MABE Test Cases**
 - **Downlinked Video**
 - **Data to be posted:**
 - **Processed Local Heat Transfer Coefficient**
 - **Synchronized Video Data (Side View and Through Array)**

Comments, Suggestions



MABE Specific:

Types of Data to see

Format of Data

PSI Database

Presentation Format

Comments, Suggestions



- Who to contact:
 - MABE: John.B.McQuillen@nasa.gov
 - Informatics Science: Robert.D.Green@nasa.gov
 - Database: Ben.Henrie@nasa.gov

A screenshot of a web browser window titled "Microheater Array Heater Boiling Experiment (MABE)". The interface has an orange header bar. Below the header, there are four buttons: "Edit Record", "Download Record", "Generate PDF", and "Share". To the right of these buttons, there is a "Was this information helpful?" section with a thumbs-up icon (0) and a thumbs-down icon (0), and a "Notify Me" checkbox. Below this is a navigation menu with tabs: "General", "Investigat...", "Scientific...", "Engineerin...", "Resulting ...", and "Comments (0)". The "Comments" tab is selected. Underneath, there is a "Comments" section with a "My Comment:" label and a large text input area. At the bottom of the input area, there is a "Post" button and another "Notify Me" checkbox.